CARBON TETRACHLORIDE

Identified as a toxic air contaminant under California's air toxic's program (AB 1807) in 1987.

CAS Registry Number: 56-23-5 CCl_4

Molecular Formula: CCl_4

Carbon tetrachloride is a nonflammable, colorless, clear, heavy liquid. It has a sweetish, aromatic, moderately strong ethereal odor resembling that of chloroform. Carbon tetrachloride is corrosive to plastics, rubber, and coatings (HSDB, 1995). It is miscible with most organic solvents such as benzene, chloroform, and ether, but is essentially insoluble in water. Carbon tetrachloride can decompose in direct flames to form phosgene and chlorine (HSDB, 1995).

Physical Properties of Carbon Tetrachloride

Synonyms: carbon chloride; carbon tet; methane tetrachloride; perchloromethane; tetrachlorocarbon; tetrachloromethane; Benzinoform; Univerm; Necatorina

Molecular Weight:	153.24
Boiling Point:	76.54 °C
Melting Point:	-23 °C
Vapor Pressure:	91.3 mm Hg at 20 °C
Vapor Density:	5.32 (air = 1)
Density/Specific Gravity:	1.5940 at 20/4 °C (water = 1)
Henry's Law Constant:	3.04×10^{-2} atm-m^3/mole at 24.8 °C
Log Octanol/Water Partition Coefficient:	2.64
Conversion Factor:	1 ppm = 6.27 mg/m^3

(HSDB, 1995; Merck, 1989; Sax, 1989; U.S. EPA, 1994a)

SOURCES AND EMISSIONS

A. Sources

In the past, carbon tetrachloride was used for dry cleaning and as a grain-fumigant. However, it is no longer allowed to be used for these purposes in the United States. The primary sources that have reported emissions of carbon tetrachloride in California are chemical and allied product manufacturers, and petroleum refineries (ARB, 1997b).

Carbon tetrachloride was used as a pesticide; however, as of January 1, 1987, it is no longer

registered for pesticidal use in California (DPR, 1996).

B. Emissions

The total emissions of carbon tetrachloride from stationary sources in California are estimated to be at least 15,000 pounds per year, based on data reported under the Air Toxics "Hot Spots" Program (AB 2588) (ARB, 1997b).

C. Natural Occurrence

Carbon tetrachloride does not naturally occur in the environment (HSDB, 1995).

AMBIENT CONCENTRATIONS

Carbon tetrachloride is routinely monitored in California by the statewide Air Resources Board (ARB) air toxics network. The network's mean concentration of carbon tetrachloride from January 1996 through December 1996 is estimated to be 0.489 micrograms per cubic meter ($\mu g/m^3$) or 0.078 parts per billion (ppb) (ARB, 1997c). When carbon tetrachloride was formally identified as a toxic air contaminant, the ARB estimated a population-weighted annual concentration of 0.82 $\mu g/m^3$, or 0.13 ppb (ARB, 1987a).

The United States Environmental Protection Agency (U.S. EPA) has also reported concentrations of carbon tetrachloride from 13 study areas during 1989 to 1991. The overall mean concentration from these areas was 1.2 $\mu g/m^3$ or 0.19 ppb (U.S. EPA, 1993a).

INDOOR SOURCES AND CONCENTRATIONS

The use of carbon tetrachloride in products to be used indoors has been discontinued in the United States. Indoor residential concentrations of carbon tetrachloride have been measured in several California studies. The most recent study was conducted in Woodland, California in the spring of 1990. The mean concentration of carbon tetrachloride of 124 samples was 0.64 $\mu g/m^3$ (0.10 ppb). Mean indoor concentrations from the Woodland study are approximately 1.2 times greater than the outdoor mean concentration of 0.52 $\mu g/m^3$ (0.08 ppb) from the same study. Carbon tetrachloride was ubiquitous in indoor air samples (Sheldon et al., 1992).

The California Total Exposure Assessment Methodology (TEAM) studies were conducted in 1984 and 1987 in and around Los Angeles and in 1984 in Contra Costa County. Mean indoor concentrations of carbon tetrachloride measured in the TEAM studies ranged from 0.63 to 1.37 $\mu g/m^3$ (0.10 to 0.22 ppb). Indoor concentrations tend to be equal to or slightly higher than outdoor concentrations (Sheldon et al., 1992).

ATMOSPHERIC PERSISTENCE

Carbon tetrachloride is a stable gaseous compound in the troposphere (lower atmosphere) with an estimated atmospheric lifetime of 50 years. Due to the lack of rapid atmospheric removal mechanisms, carbon tetrachloride accumulates in the troposphere. This accumulation has created a global background concentration which is estimated to be between 0.69 and 0.94 $\mu g/m^3$ (ARB, 1987a).

The mechanisms to remove carbon tetrachloride from the troposphere act very slowly. Some of these removal mechanisms include ultraviolet photolysis in the stratosphere, and absorption into the oceans. Ultraviolet photolysis in the stratosphere is recognized as the major route by which carbon tetrachloride is removed. One of the photolysis products is chlorine (ARB, 1987a).

AB 2588 RISK ASSESSMENT INFORMATION

The Office of Environmental Health Hazard Assessment reviews risk assessments submitted under the Air Toxics "Hot Spots" Program (AB 2588). Of the risk assessments reviewed as of April 1996, carbon tetrachloride was the major contributor to the overall cancer risk in 3 of the approximately 550 risk assessments reporting a total cancer risk equal to or greater than 1 in 1 million and contributed to the total cancer risk in 43 of the these risk assessments. Carbon tetrachloride also contributed to the total cancer risk in 18 of the approximately 130 risk assessments reporting a total cancer risk greater than or equal to 10 in 1 million (OEHHA, 1996a).

For non-cancer health effects, carbon tetrachloride contributed to the total hazard index in 5 of the approximately 89 risk assessments reporting a total chronic hazard index greater than 1. Carbon tetrachloride also contributed to the total hazard index in 8 of the approximately 107 risk assessments reporting a total acute hazard index greater than 1, and presented an individual hazard index greater than 1 in 1 of these risk assessments (OEHHA, 1996b).

HEALTH EFFECTS

The most probable route of human exposure to carbon tetrachloride is inhalation (U.S. EPA, 1994a).

Non-Cancer: Carbon tetrachloride is a central nervous system depressant and mild eye and respiratory tract irritant. It is highly hepato- and nephro- toxic. Numerous studies have suggested that carbon tetrachloride is metabolized to a highly reactive trichloromethyl radical which can then react with cellular components to produce acute and chronic toxicity. Acute inhalation and oral exposures to carbon tetrachloride by humans has resulted in hepatitis and kidney damage as well as central nervous systems effects of headache, nausea, vomiting, lethargy, and weakness. It may sensitize the heart muscle to the arrhythmogenic effects of epinephrine. Chronic inhalation or oral exposure to carbon tetrachloride produces liver and kidney damage in

humans. Long-term animal exposure to similar levels of carbon tetrachloride found in occupational settings has produced liver and kidney damage.

An acute non-cancer inhalation Reference Exposure Level (REL) of 1.9×10^2 $\mu g/m^3$ is listed for carbon tetrachloride in the California Air Pollution Control Officers Association Air Toxics "Hot Spots" Program, Revised 1992 Risk Assessment Guidelines. The toxicological endpoint considered for chronic toxicity is the central nervous system. Also, a chronic REL of 2.4 $\mu g/m^3$ is listed in the CAPCOA Risk Assessment Guidelines with the liver as the toxicological endpoint (CAPCOA, 1993). Although the U.S. EPA has not established a Reference Concentration (RfC) for carbon tetrachloride they have determined an oral Reference Dose (RfD) for carbon tetrachloride of 7×10^{-4} milligram per kilogram per day based on liver lesions in rats. The U.S. EPA estimates that consumption of this dose or less, over a lifetime, would not likely result in the occurrence of chronic, non-cancer effects (U.S. EPA, 1994a).

No information is available on adverse reproductive or developmental effects of exposure to carbon tetrachloride in humans (U.S. EPA, 1994a). Inhaled carbon tetrachloride causes degenerative changes in the testes and reduced testicular weight in laboratory animals. Reduced fertility in rats has been observed. In pregnant female rats exposed to carbon tetrachloride, it crossed the placenta and produced reduced fetal body weight and crown-rump length (ATSDR, 1994a; U.S. EPA, 1984b). The teratogenic potential of carbon tetrachloride has not been adequately tested (ARB, 1987a).

Cancer: The occurrence of liver cancer in workers who were exposed to carbon tetrachloride by inhalation has been studied but the data are inconclusive (U.S. EPA, 1994a). Carbon tetrachloride has been shown to produce liver tumors in mice, rats, and hamsters by the oral, subcutaneous and rectal routes. In some of these studies, carbon tetrachloride produced hepatic tumors in up to 100 percent of the animals. No animal inhalation studies have been conducted (ARB, 1987a).

The U.S. EPA classified carbon tetrachloride in Group B2: Probable human carcinogen based on sufficient evidence for carcinogenicity in animals and inadequate evidence in humans, and determined an inhalation potency value of 1.5×10^{-5} (microgram per cubic meter)$^{-1}$. The U.S. EPA estimates that if an individual were to breathe air containing carbon tetrachloride at 0.07 $\mu g/m^3$, over a lifetime, that person would theoretically have no more than a 1 in 1 million increased chance of developing cancer (U.S. EPA, 1994a). The International Agency for Research on Cancer classified carbon tetrachloride as Group 2B: Possible human carcinogen based on sufficient evidence in animals and inadequate evidence in humans (IARC, 1987a).

The State of California under AB 1807 identified carbon tetrachloride as a Toxic Air Contaminant and as a carcinogen under Proposition 65 (ARB, 1987a; CCR, 1996). The inhalation potency factor that has been used as a basis for regulatory action in California is 4.2×10^{-5} (microgram per cubic meter)$^{-1}$ (OEHHA, 1994). In other words, the potential excess

cancer risk for a person exposed over a lifetime to 1 $\mu g/m^3$ of carbon tetrachloride is estimated to be no greater than 42 in 1 million. The oral potency factor that has been used as a basis for regulatory action in California is 1.5×10^{-1} (milligram per kilogram per day)$^{-1}$ (OEHHA, 1994).